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Title:

A framework for assessing the impact of units of scholarly communication based on OAI-PMH harvesting of usage information

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A framework for assessing the impact of units of scholarly communication based on OAI-PMH harvesting of usage information.

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“A cynic knows the price of everything, but the value of nothing”

- Evaluation of scholarly communication and production matters greatly:
  - Implications for individual researchers:
    - Publishing decisions
    - Career options
    - Collaboration choices
  - Resource allocation
    - Teams
    - Universities
    - Institutions
    - Nations
  - Bibliometrics
    - Trends
    - Process

- Science is unfortunately not evaluated on its inherent value, but by its “by-products”, in particular publication

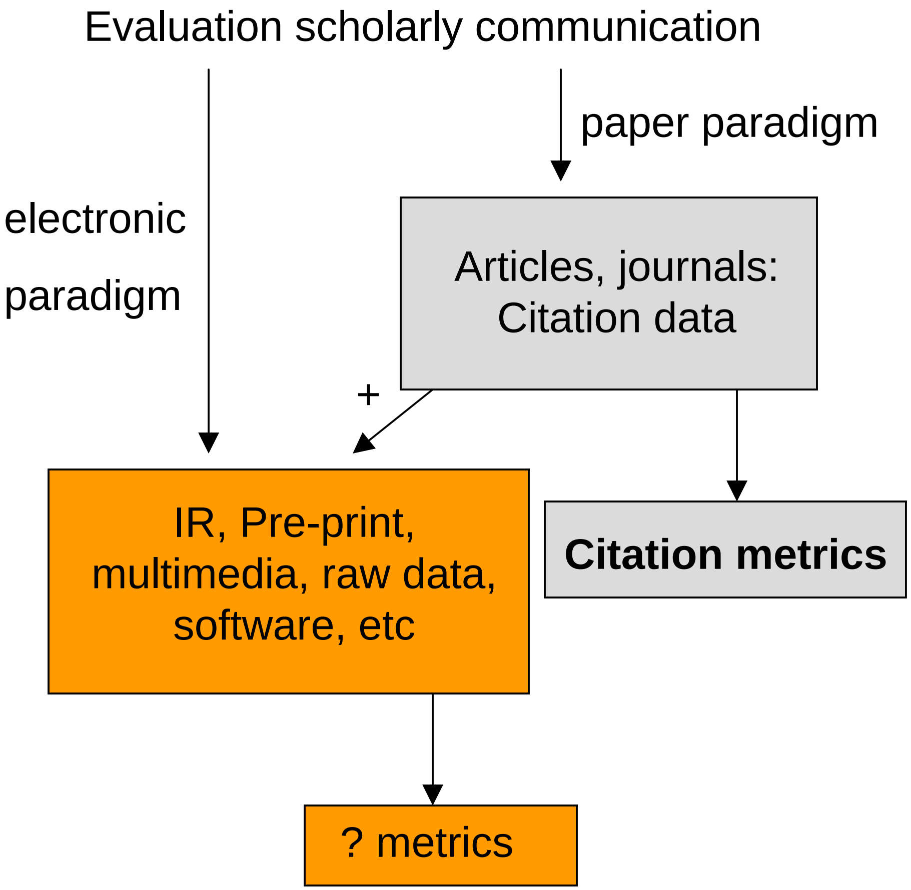
- A short-cut to expert evaluation: citation analysis
  - Citation indicates endorsement of published work by publishing peers
  - Count citations for researcher, departments, universities, nations to rank their prestige and productivity

- Pervasive approach in academia and elsewhere
  - Driven by availability of vetted citation data: Thomson Scientific ISI Journal Citation reports and Impact Factors
  - Applied in all areas of evaluation

What's going on in science evaluation?

- A paper economy
  - Citable, published literature only
  - Corresponding metrics: citation frequency
  - Someone dictates what we count and how we count

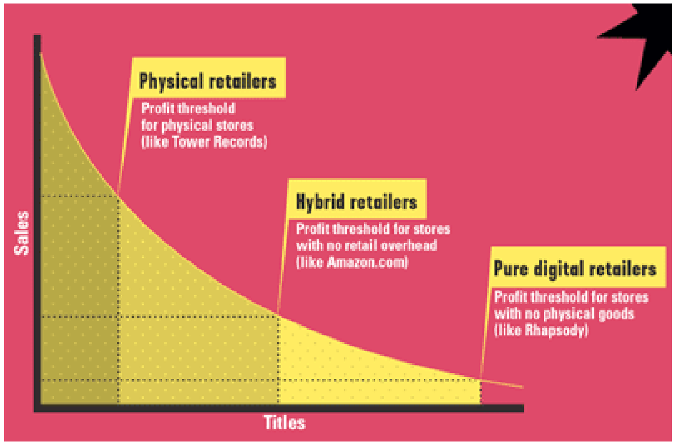
- Electronic paradigm
  - New models of communication
  - New models of scholarship
  - New metrics of evaluation?


Evaluation scholarly communication
paper paradigm
electronic
paradigm
Articles, journals: Citation data
+
IR, Pre-print, multimedia, raw data, software, etc
Citation metrics
? metrics

Science evaluation on the long tail

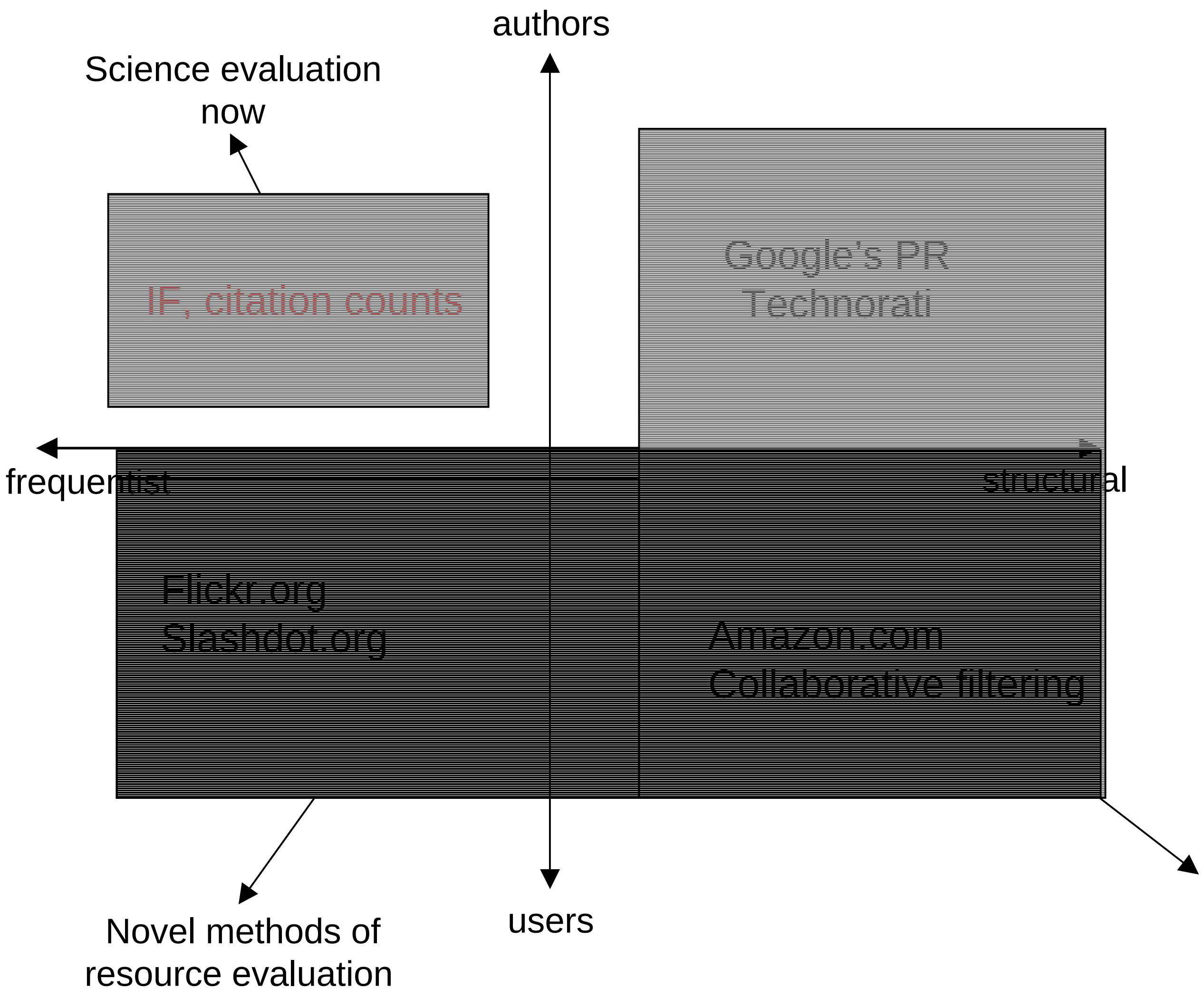
- Short front
  - Not everything can be published: selection and pruning process
  - Publication delays: the world as it was 3 years go
  - Use of citation as endorsement indicator: expert endorsement
  - Not every citation is counted: need for standardized, limited, and vetted data sets (ISI)

- **Long tail**
  - Everything will be published somehow
  - Immediate, electronic access to all stages of scholarly process
  - Many possible indicators of endorsement and interest (hyperlinks, readership, ratings)
  - No privileged access: all can count, all will be counted



Chris Anderson (2004),Wired, 12.10

The long tail: a user-driven revolution.



Evaluation of resources (quality, status, pretige) is required on all levels of our digital infrastructure:

•Most solutions adopted differ from citation analysis with regards to:

- •Different data sources
- •Different metrics

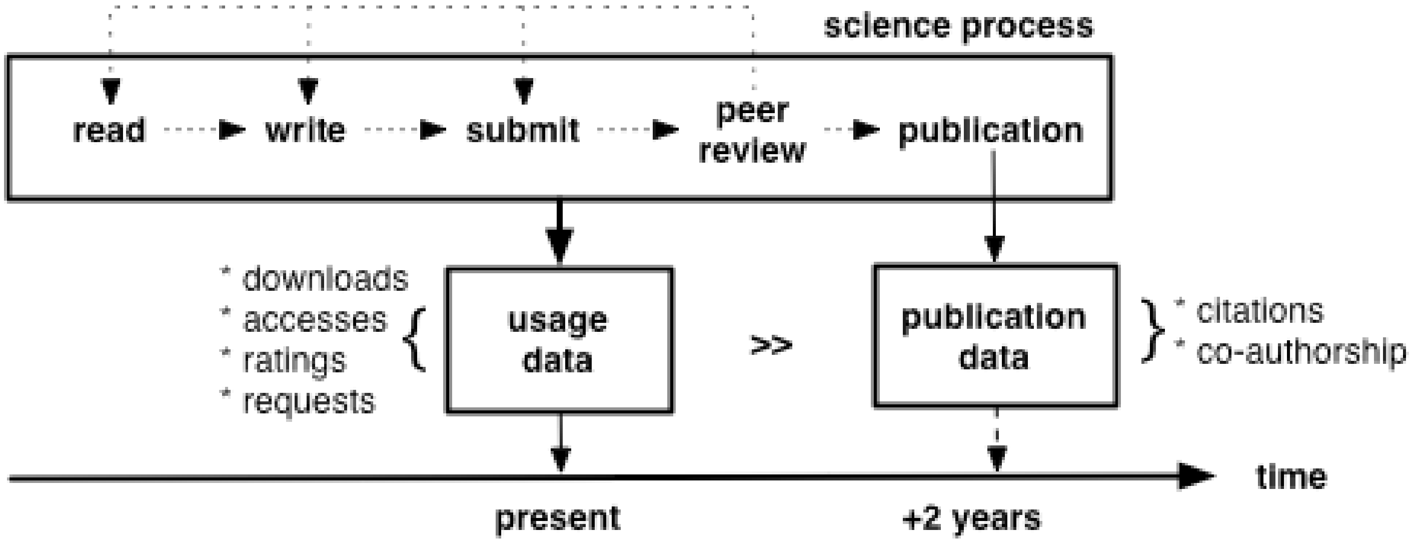
• Trend:

- •author controlled to user controlled
- •Frequentist to structural

LANL approach since 1999:
•Derive relational information from reader/user interest and citation data
* Structure defines status/prestige (social network science)

The importance of usage information.

- Recorded in the present (usage), not 3-4 years after fact (citation)
- Unlimited access, unlimited sample size
- Already recorded locally at many different information resources
- Reduced “social desirability bias”
- Recorded at all stages of the scholarly process
- Applies to all units of scholarly communication



Beyond linear click streams: mining usage data for item relationships

Citation

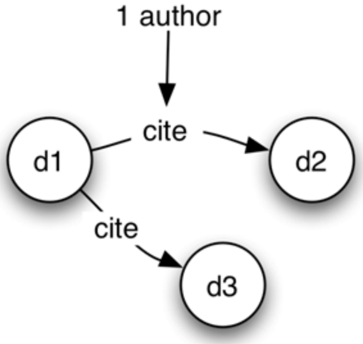
1) When an author cites B from A,
   A and B are related
2) The frequency of citation corresponds to
   degree of relatedness (journals)

↔

Clickstream/data mining approach:

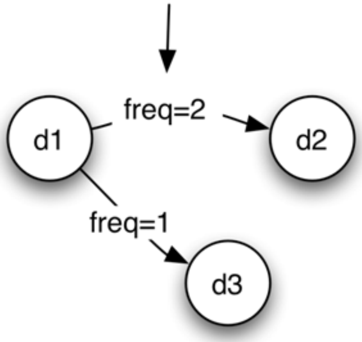
1) When a user downloads A and B,
   A and B may be related.
2) The co-download frequency corresponds to
   degree of relatedness (all docs)

citation data



usage: download log

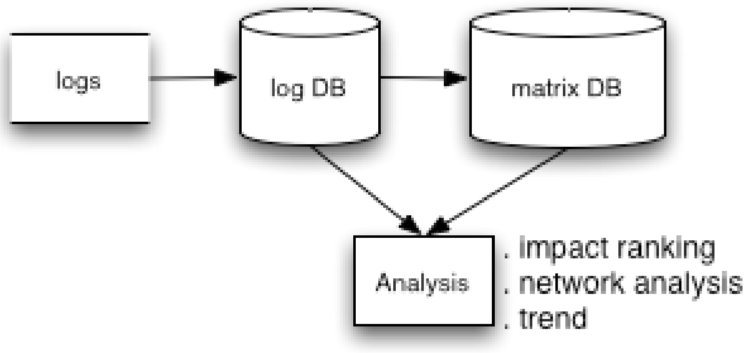
```
user1   date1   time1   d1 } co-download(d1,d2)
user1   date1   time2   d2                          } : freq(d1,d2)=2
user2   date2   time3   d1 } co-download(d1,d2)
user2   date2   time4   d2
user3   date3   time5   d1 } co-download(d1,d3)   : freq(d1,d3)=1
user3   date3   time6   d3
```



- *Kothari (2003). On using page cooccurence …*
- *Kim (2004). A clickstream-based collaborative…*
- *Sarwar (2001. Item-based collaborative filtering*

Local experiences at the LANL RL

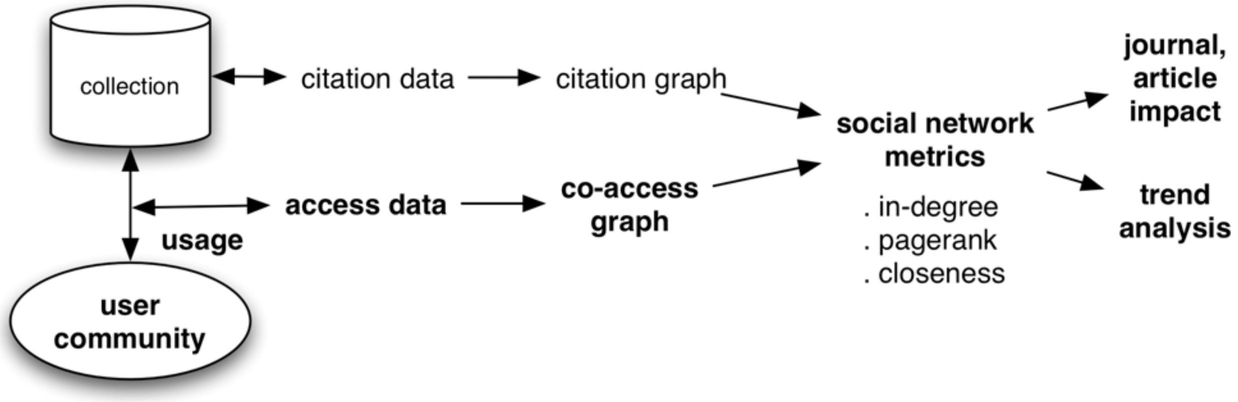
- Collect reliable usage data from multiple service providers at LANL
- Logs include all user expressions of interest
  - Request for metadata: author, abstract, reference, etc
  - Full-text downloads
  - …
- Most recent analysis: February 2004 to April 2005:
  - 392,455 usage events : any indication of preferences/interest
  - 5,866 users
  - 330,109 articles
  - 10,695 journals



Analysis focuses on:

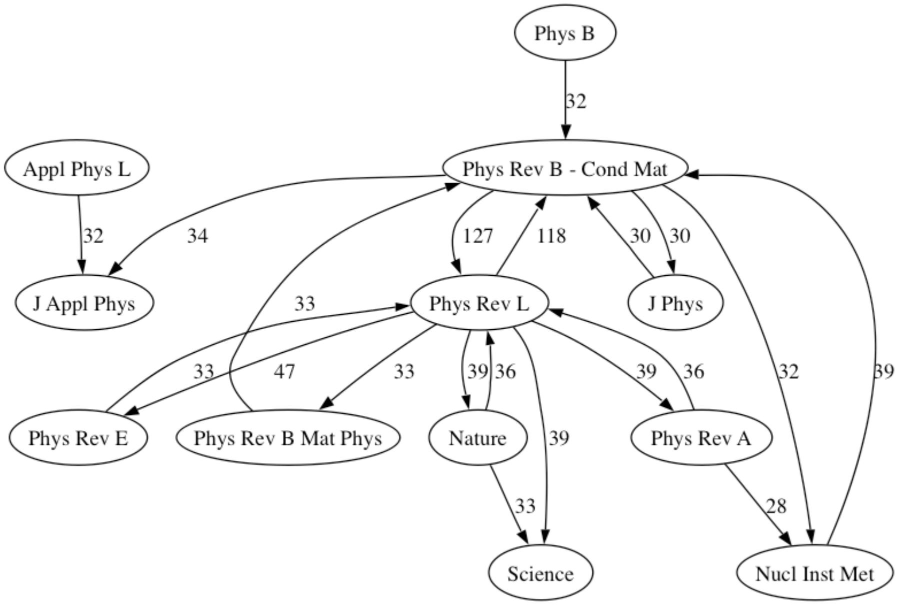
1) Journal impact metrics:
   - Frequency
   - In-degree (IF)
   - PageRank
2) Trend: comparison to citation data

LANL usage analysis methodology

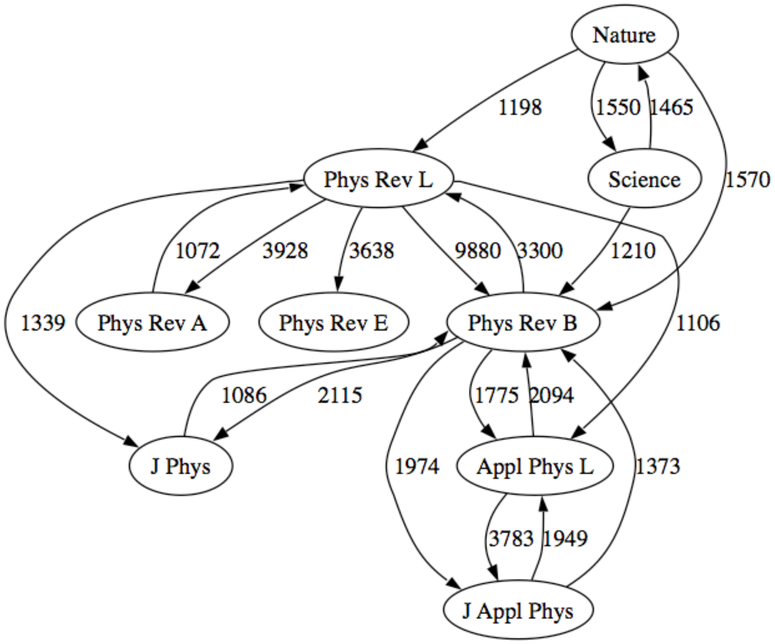


Usage: user activity that expresses interest or preference
Access data: particular instance(s) of usage (e.g. request abstract, download full-text)
Co-access: repeated instances of same user accessing pairs of items (documents)
Co-access graph: network of co-access data
Social network metrics: prestige from network structure

Journal matrix (02/2004-04/2005)



LANL 2004 data : top edges



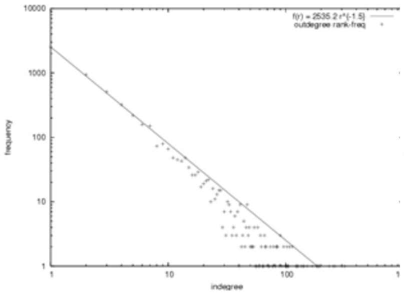
JCR2001 data : top edges

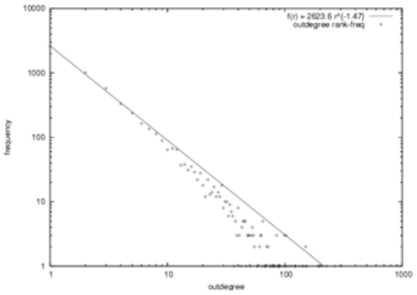
Resulting journal matrix:

- 33,256 edges
- 7,099 journals
- Density: 6.6 x 10^{-4}

Degree distribution:

- Power law, $f = k * r^{-a}$
- Small-world graphs



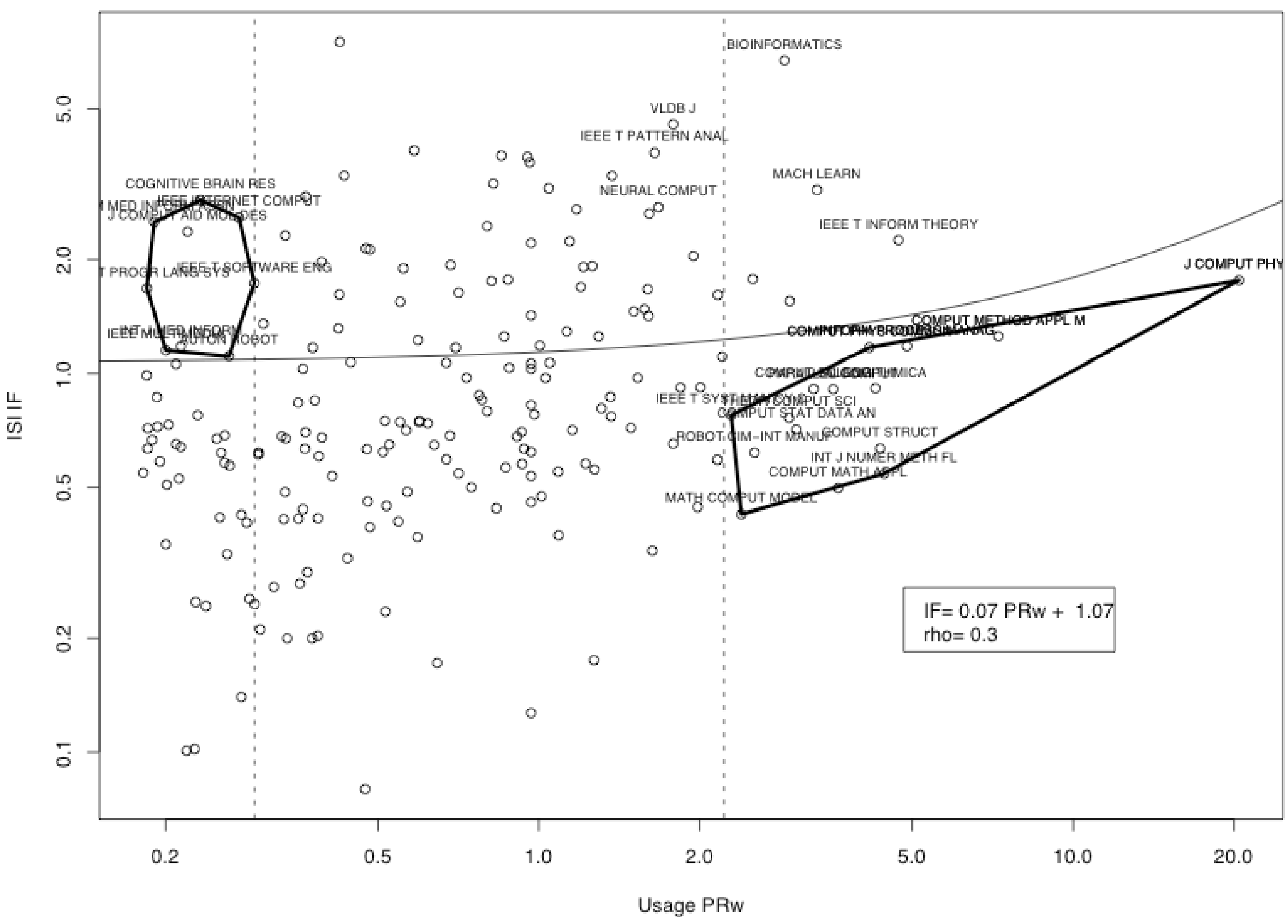


A comparison of LANL usage and citation impact

rank	Usage (PageRank)	IF (2003)	ISSN	Title (abbv.)
1	60.196	7.035	0031-9007	PHYS REV LETT
2	37.568	2.950	0021-9606	J CHEM PHYS
3	34.618	1.179	0022-3115	J NUCL MATER
4	31.132	2.202	1063-651X	PHYS REV E
5	30.441	2.171	0021-8979	J APPL PHYS
6	30.128	30.979	0028-0836	NATURE
7	29.972	29.781	0036-8075	SCIENCE
8	27.187	6.516	0002-7863	J AM CHEM SOC
9	24.602	4.049	0003-6951	APPL PHYS LETT
10	23.631	2.992	0148-0227	J GEOPHYS RES

Users and authors agree. Somewhat.

LANL04 Usage Weighted PageRank vs. 2003 IF (Computer Science)



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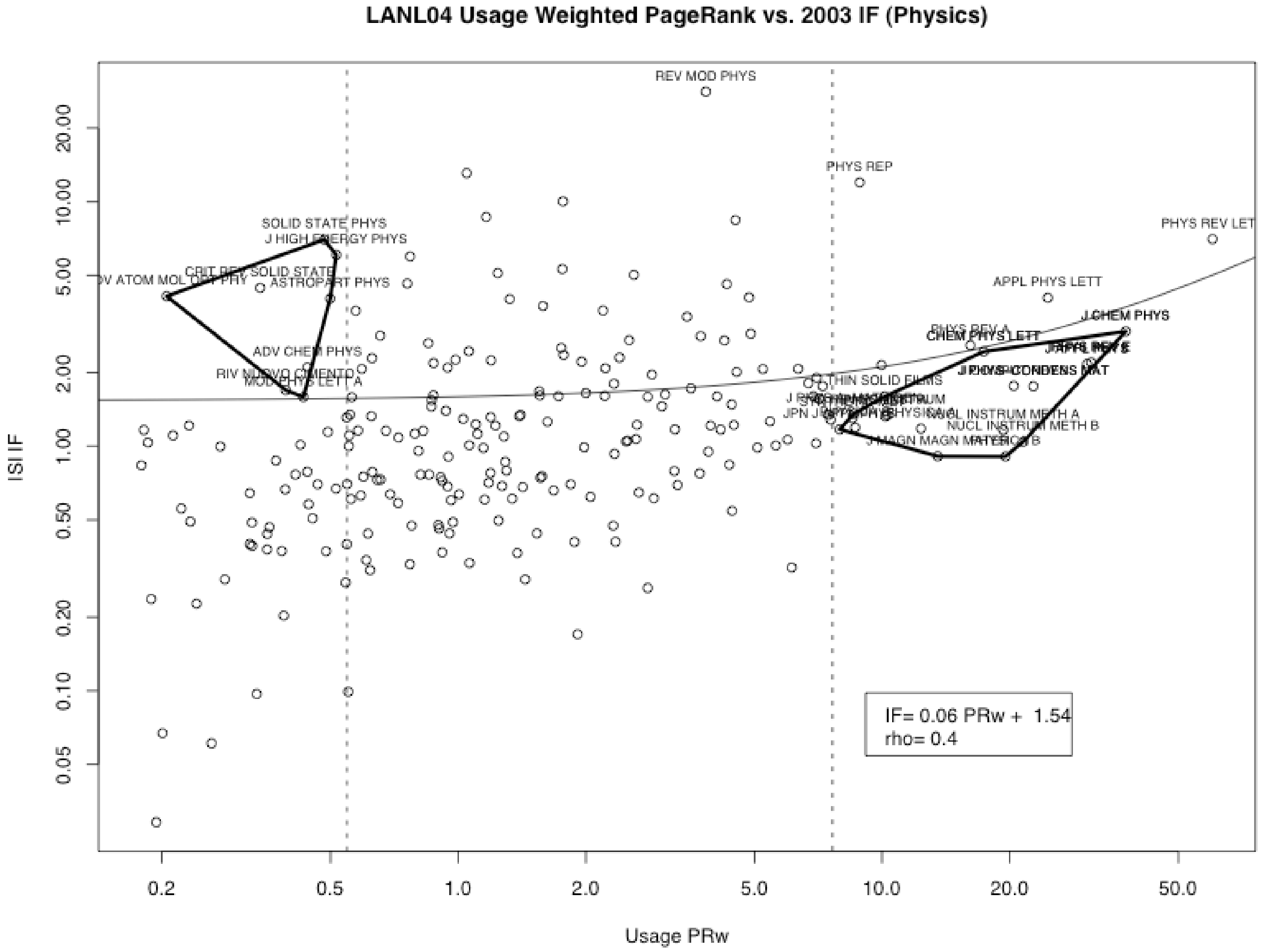
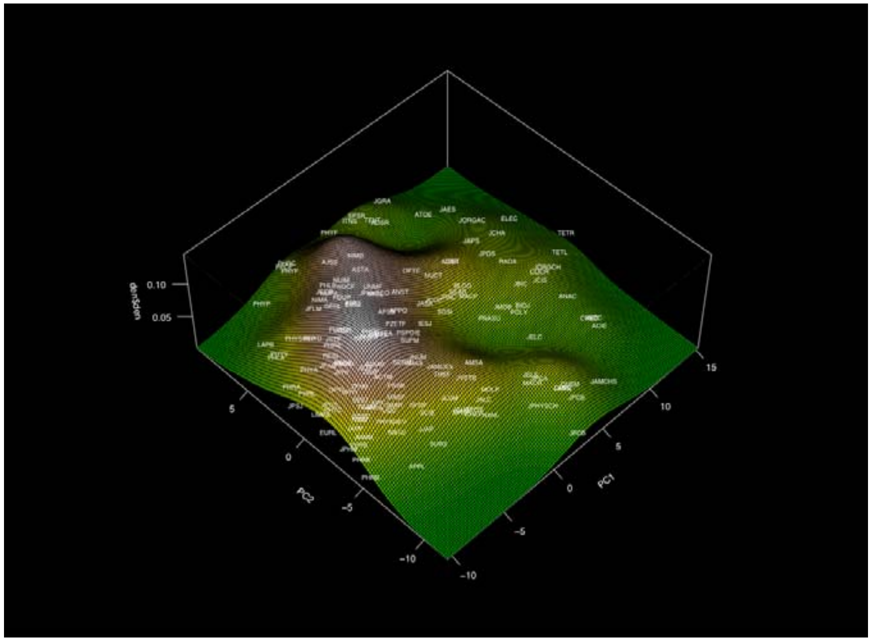
Users and authors agree. Somewhat.

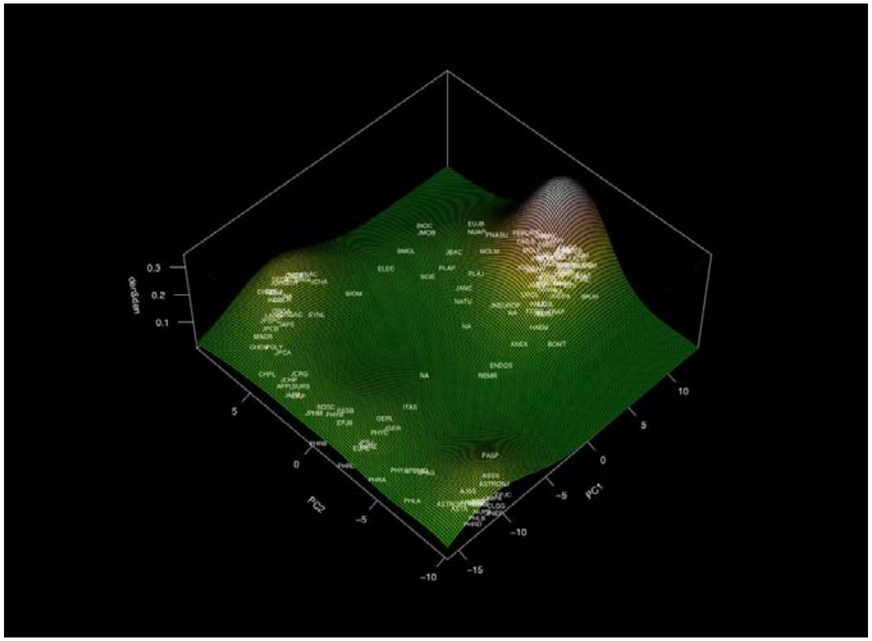


LANL04 Usage Weighted PageRank vs. 2003 IF (Physics)

Information landscapes:
studying the structure and evolution of science



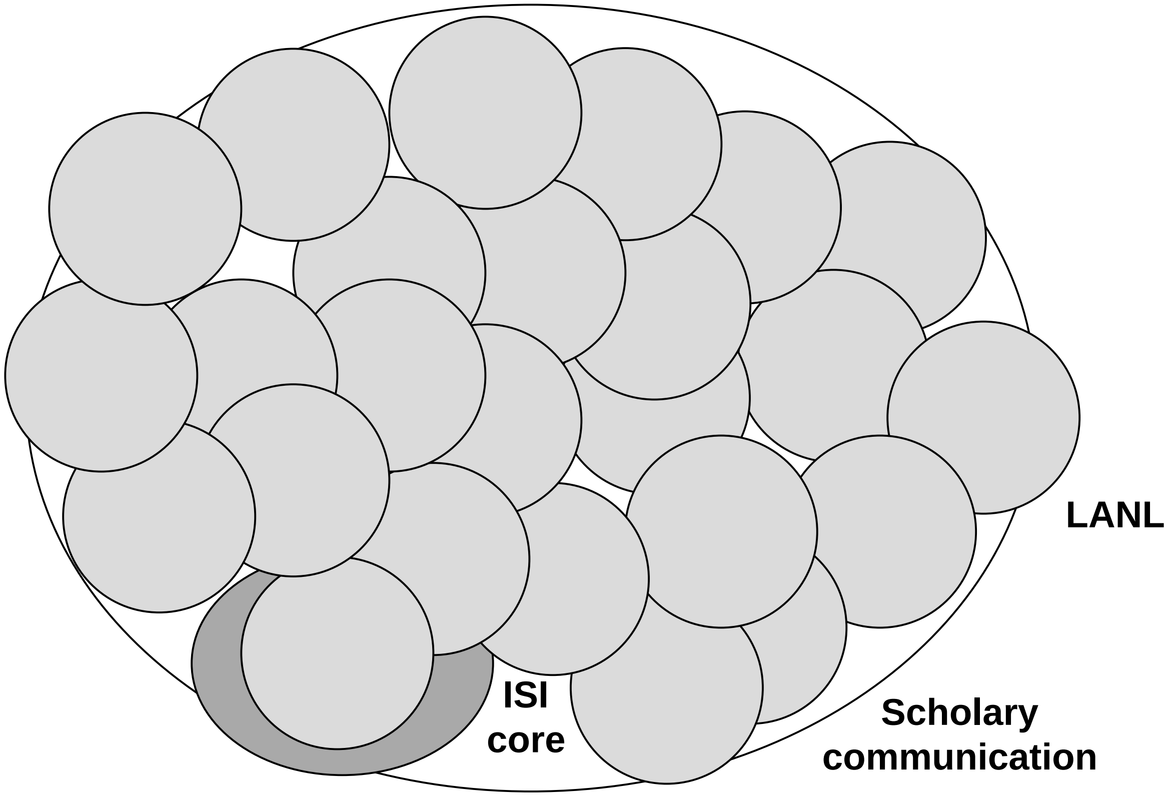
LANL04



JCR03

- **Two component model**
- **PC1: Life vs. natural science**
- **PC2: Microscopic vs. macroscopic**
- **Z-axis: cluster density**

From local usage to global coverage



- Local usage is interesting
  - Informs local collection management
  - Prominent communities can inform assessments of science trends
  - Covers wide range of communication items
  - Immediate availability
- Global, aggregated usage data is even more interesting
  - Monitor science as it takes place
  - Replace/augment/validate proprietary data sets
  - Allow free-form aggregation:
    - Clusters of institutions
    - Focus on sub-domains and communities

Challenges applying usage data in “global” scholarly evaluation .

- Institutional rights and biases
  - Registered locally:
    - Proprietary?
    - Privacy issues
- Standardization
  - What usage is being recorded?
  - How is it registered and stored?
- Aggregation and scalability
  - Joining logs from different origins is required for “global” analysis beyond institution
  - Standardization and scalability issues
- Metrics
  - Frequentist metrics indicate popularity not impact/quality
  - Structual metrics require structural data: linear usage logs?

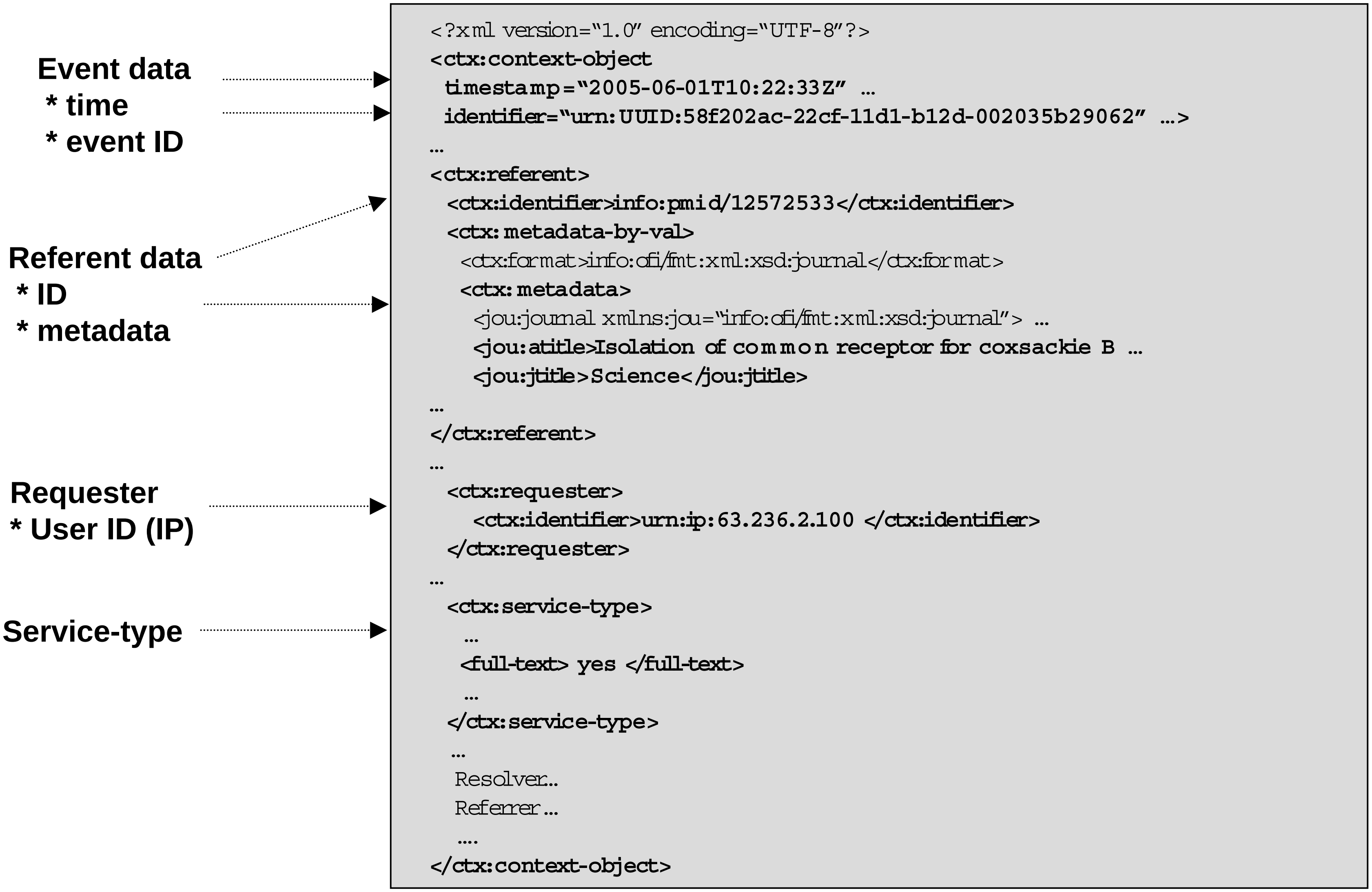
- LANL solution (3 components):
  - Standards: OAI-PMH and OpenURL ContextObjects for log harvesting
    - Logs exposed and harvested using OAI-PMH
    - Usage data represented using OpenURL ContextObjects
  - Data mining:
    - Derive document relationships from access sequences
  - Metrics:
    - Recommender system
    - Structural metrics of impact/prestige/prominence

Transport and representation

- OAI-PMH
  - Data provider exposes access logs via OAI-PMH repository
  - Metadata exposed = usage event data
    - Who?
    - What?
    - When?
    - How?
  - Expressed as XML OpenURL ContextObjects
  - Harvested by aggregator

- **OpenURL ContextObjects for log data**:
  - Each object assigned globally unique ID, i.e. UUID
  - Timestamp: recorded time of event
- **Referent**:
  - One or more identifiers (URIs) for resource involved in event
  - By_value Metadata Descriptor
- **Requeste**r:
  - Requester associated with event, i.e. user
  - Currently only the IP address of the Requester's machine, urn:ip:....
- **Service-type**: By_value Metadata Descriptor for the Service Types involved in the event
- **Resolve**r: One or more identifiers for the OpenURL Resolver
- **Referrer**: identifiers for referrer involved in event

OpenURL ContextObject for usage event data



Event data
*** time**
*** event ID**

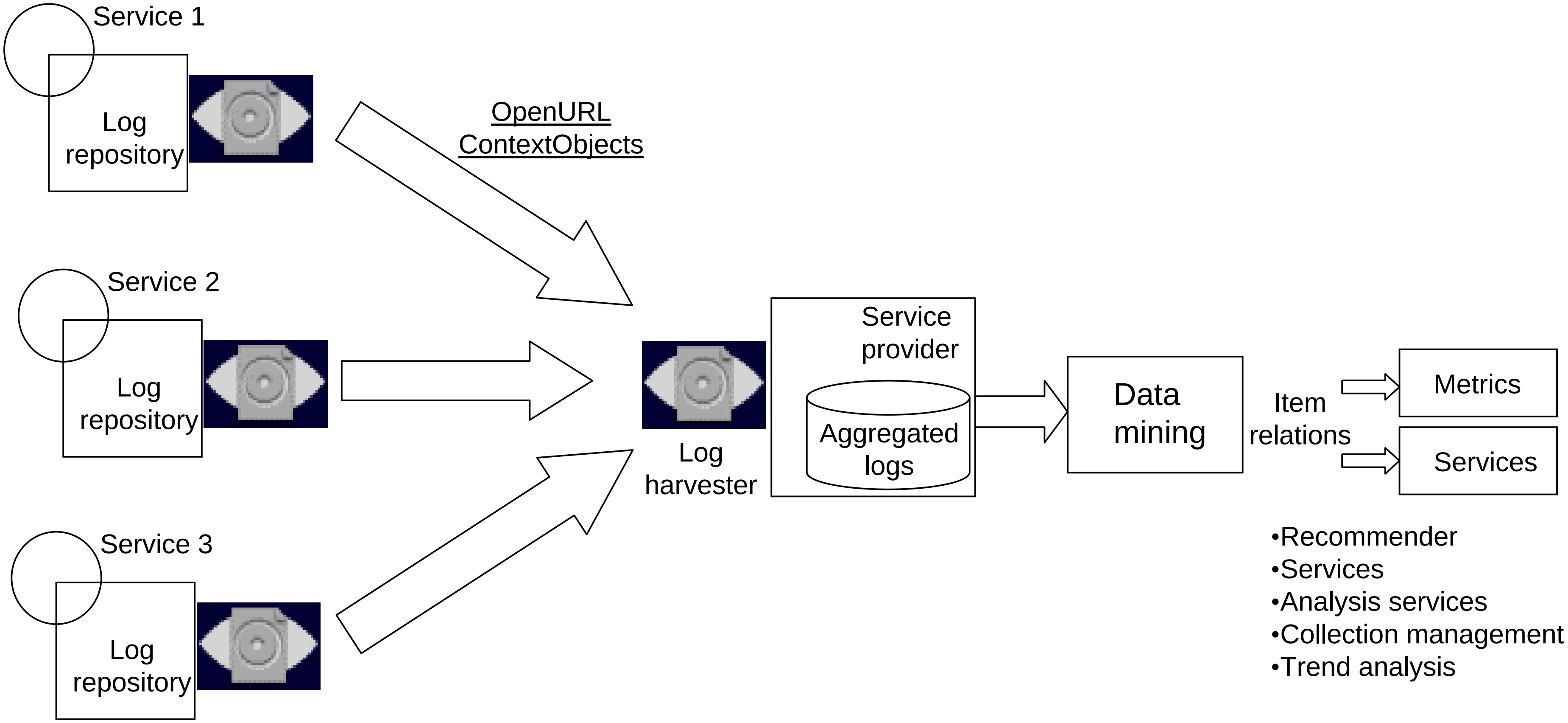
Referent data
*** ID**
*** metadata**

Requester
*** User ID (IP)**

Service-type

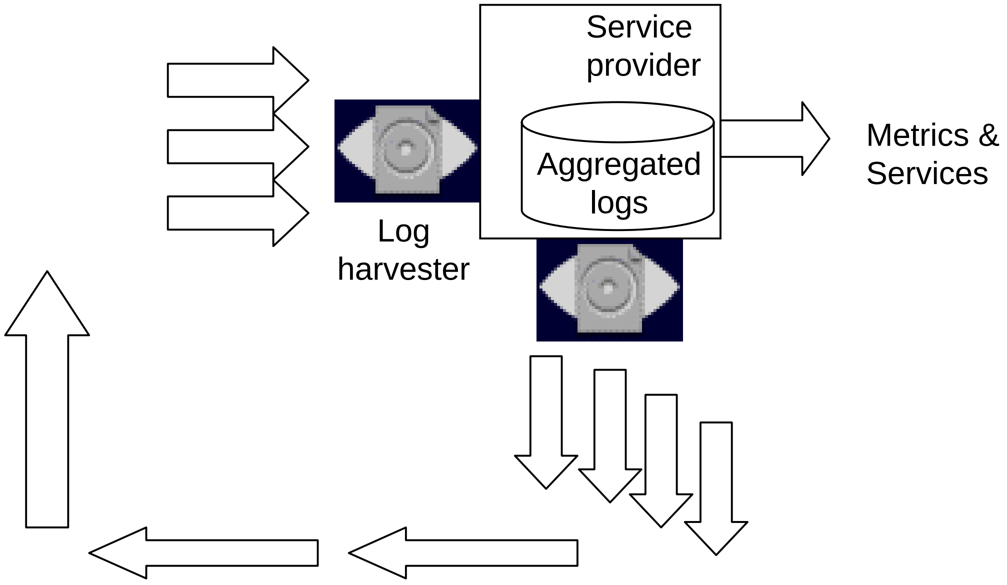
```
<?xml version="1.0" encoding="UTF-8"?>
<ctx:context-object
 timestamp="2005-06-01T10:22:33Z" …
 identifier="urn:UUID:58f202ac-22cf-11d1-b12d-002035b29062" …>
…
<ctx:referent>
  <ctx:identifier>info:pmid/12572533</ctx:identifier>
  <ctx: metadata-by-val>
   <ctx:format>info:ofi/fmt:xml:xsd:journal</ctx:format>
   <ctx: metadata>
    <jou:journal xmlns:jou="info:ofi/fmt:xml:xsd:journal"> …
    <jou:atitle>Isolation of common receptor for coxsackie B …
    <jou:jtitle>Science</jou:jtitle>
…
</ctx:referent>
…
  <ctx:requester>
    <ctx:identifier>urn:ip:63.236.2.100 </ctx:identifier>
  </ctx:requester>
…
  <ctx:service-type>
    …
   <full-text> yes </full-text>
    …
  </ctx:service-type>
   …
   Resolver…
   Referrer …
   ….
</ctx:context-object>
```

General architecture



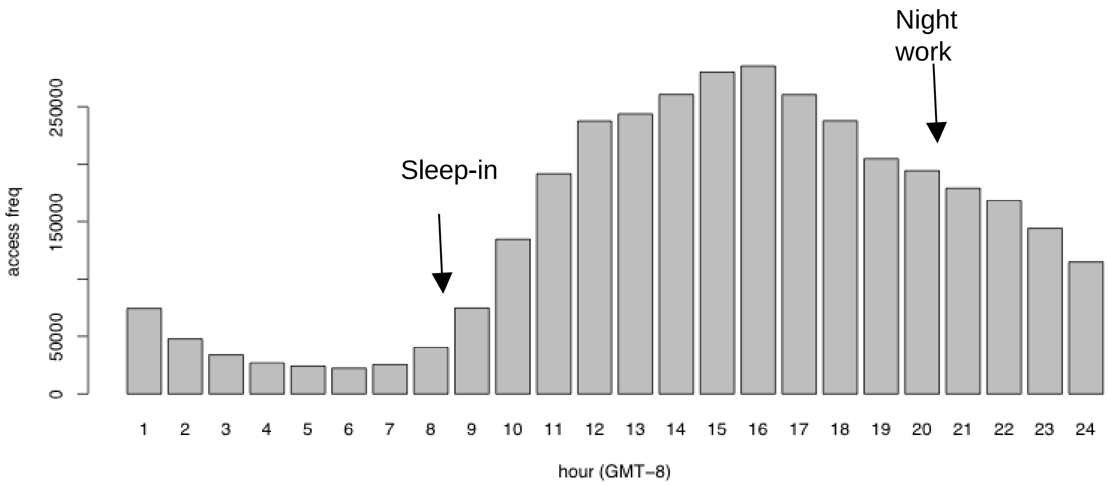
- Recommender
- Services
- Analysis services
- Collection management
- Trend analysis

Community-centric vs. global services: incentives to federate



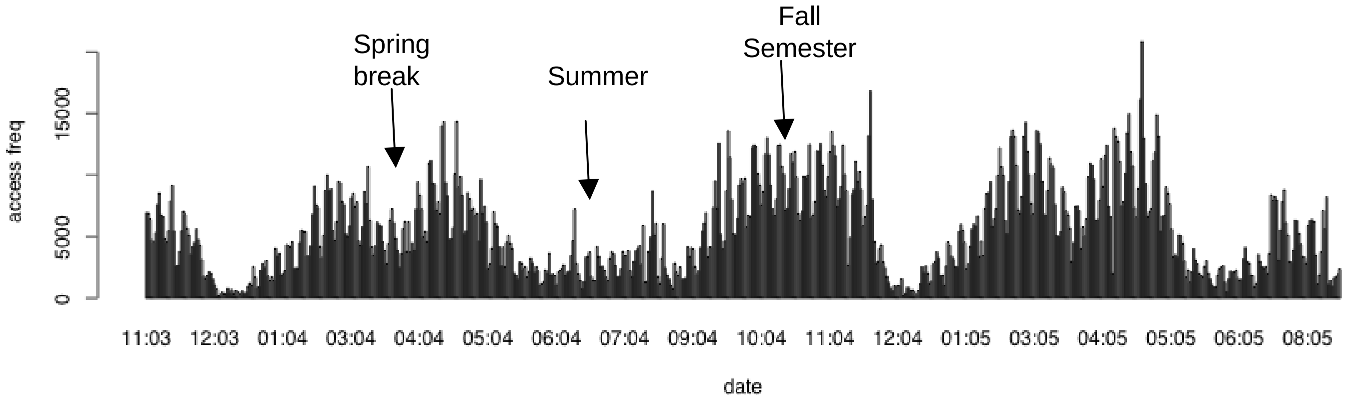
- Every instance can act as both a aggregator and data provider: re-expose or not?
- Local Benefits: Benefits when not exposing log data:
  - Local recommender services
  - Local collection management data
  - Local trend data
- But wouldn't you want more?
- Exposing logs for harvesting:
  - Obtain permission to harvest from global or federated data set
  - Acquire global services
  - Be represented: is your community included?
- Possible mergence of 3rd federators
  - Provides trusted global analysis
  - Services based on global data
  - Re-exposes vetted, federated data

Some statistics: the academic rhythm


Night work

Sleep-in

- Logs collected at 9 institutions and LANL federated
- 3,507,484 unique events
- 2,133,556 unique documents
-167,204 unique agents (users)
- Recorded: November 2003 to August 2005
- 67% article events, 25% journal events


Spring break

Summer

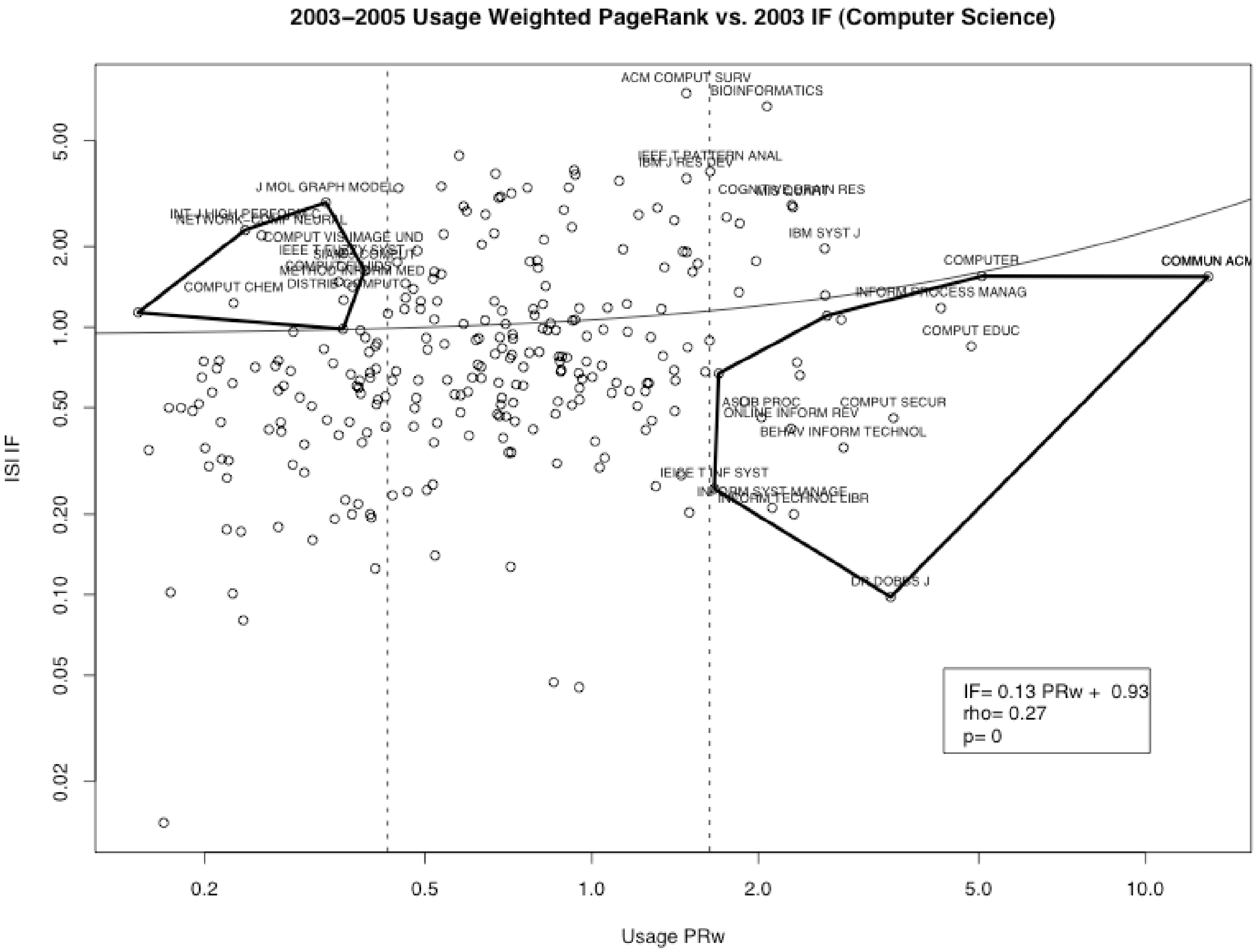
Fall Semester

QuickTime™ and a
Graphics decompressor
are needed to see this picture.

Results: journal ranking

rank	Usage (PageRank)	IF (2003)	ISSN	Title (abbv.)
1	78.565	21.455	0098-7484	JAMA-J AM MED ASSOC
2	71.414	29.781	0036-8075	SCIENCE
3	60.373	30.979	0028-0836	NATURE
4	40.828	3.779	0890-8567	J AM ACAD CHILD PSY
5	39.708	7.157	0002-953X	AM J PSYCHIAT
6	38.113	34.833	0028-4793	NEW ENGL J MED
7	37.492	3.363	0090-0036	AM J PUBLIC HEALTH
8	37.031	2.591	0195-9131	MED SCI SPORT EXER
9	27.248	0.998	0309-2402	J ADV NURS
10	26.987	5.692	0002-9165	AM J CLIN NUTR

Comparison journal usage and citation IF



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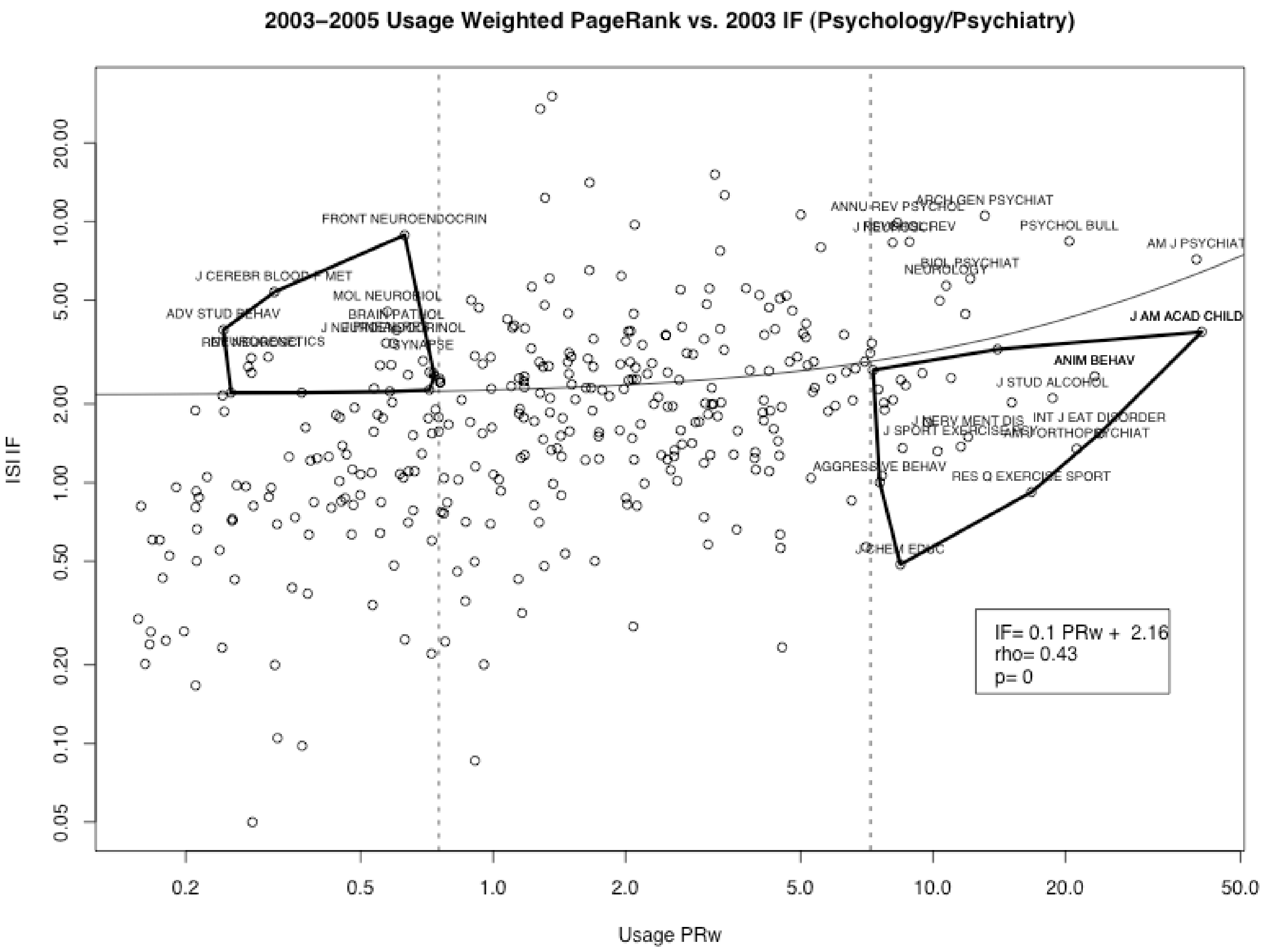
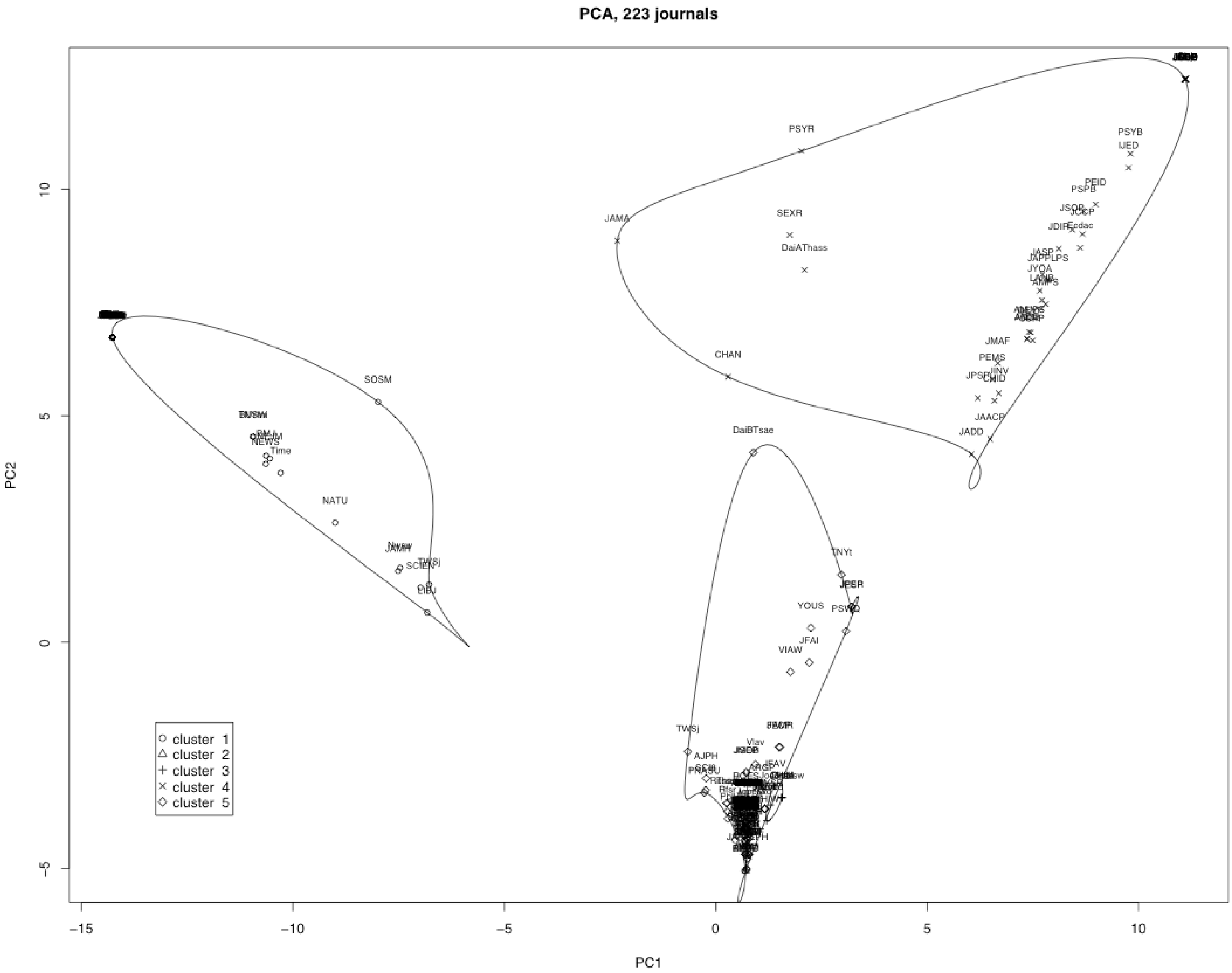
Comparison journal usage and citation IF, contd.



Mapping the structure of science



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Article level data

Frequency	Article
441	Cardell Jacobson (2001) Religion, Religiosity, and Attribution of Responsibility. Research in the social scientific study of religion 12: 117
273	J. Sloan (2004) Respondent Misreporting of Drug Use in Self-Reports: Social Desirability and Other Correlates. Journal of Drug Issues 34:269
242	Zaborski, E. R. (2002). Observations on feeding behavior by the terrestrial flatworm Bipalium adventitium. Am. Midl. Nat. 148:201
187	Genz (1998) Working the reference desk. Library Trends, 46:505
185	C. D. Fiore (1998) The numbers game: how to fatten your budget by using statistics", School Library Journal, 44(3)
163	Van Horn (2002). The Digital Millennium Copyright Act and Other Egregious Laws. Phi Delta Kappan. 84:248
185	Iglehart (2002).: Hispanic and African American Youth: Life after Foster Care Emancipation. Journal of ethnic & cultural diversity in social work. 11:79
145	Stoffle (1994), “No Place for Neutrality: the Case for Multiculturalism,” *Library Journal* 119:46
133	Simpson (1999) Managing Copyright in Schools. Knowledge quest. 28:18
129	Heppermann (1998). Little house on the bottom line. The horn book magazine 74:689

Usage-based recommender system

- Operates on network derived from aggregated usage
- Starts from (set of) documents (articles or journals)
- Scans usage network links for direct and indirectly related documents
- Results:
  - Scalable
  - Highly efficient
  - Highly relevant results derived from accumulated, aggregated usage

Movie: article level recommendations

Movie: journal level recommendations

Conclusion

- Scholarly communication is going through a revolution
- Scholarly evaluation will too! Focus will be on
  - Immediacy
  - Representativeness
  - Openness, standards and scalability
  - Acknowledging structural aspects of prestige and impact in the scholarly community
- User driven evaluation offers an interesting alternative to current short-front evaluation methods in a long-tail world

- Feasibility of usage analysis demonstrated at local and semi-global level
  - LANL results indicate:
    - Possibility of local prestige and impact ranking
    - Additional usage-based services such as recommender systems possible
  - Aggregated data and analysis:
    - Large-scale aggregation demonstrated scalability
    - Use of existing standards ensures openness, ability of all to participate
    - Possibility of spontaneous emergence of vetting and standardization system for usage quality indicators
    - Enticing community and global recommender services offer further incentives to adopt locally and collaborate globally

Some papers:

- **J. Bollen, H. V. de Sompel, J. Smith, and R. Luce**. Toward alternative metrics of journal impact: a comparison of download and citation data. *Information Processing and Management*, 41(6):1419-1440, 2005.
- **J. Bollen, R. Luce, S. Vemulapalli, and W. Xu**. Detecting research trends in digital library readership. In *Proceedings of the Seventh European Conference on Digital Libraries (LNCS 2769)*, pages 24-28, Trondheim, Norway, August 18 2003. Springer-Verlag.
- **J. Bollen, R. Luce, S. Vemulapalli, and W. Xu**. Usage analysis for the identification of research trends in digital libraries. *D-Lib Magazine*, 9(5), 2003.